

CLAIMS

1. Apparatus for treating a condition of an ear of a subject, comprising a stimulator adapted to stimulate at least one site of the subject at a level sufficient to treat the ear condition, the site selected from the list consisting of: an otic ganglion of the subject, an
5 afferent fiber going into the otic ganglion of the subject, an efferent fiber going out of the otic ganglion of the subject, a sphenopalatine ganglion (SPG) of the subject, an anterior ethmoidal nerve of the subject, a posterior ethmoidal nerve of the subject, a communicating branch between an anterior ethmoidal nerve and a retro-orbital branch of an SPG of the subject, a communicating branch between a posterior ethmoidal nerve and
10 a retro-orbital branch of an SPG of the subject, a greater palatine nerve of the subject, a lesser palatine nerve of the subject, a sphenopalatine nerve of the subject, a communicating branch between a maxillary nerve and an SPG of the subject, a nasopalatine nerve of the subject, a posterior nasal nerve of the subject, an infraorbital nerve of the subject, a vidian nerve of the subject, a greater superficial petrosal nerve of the
15 subject, and a lesser deep petrosal nerve of the subject.
2. The apparatus according to claim 1, wherein the condition includes Meniere's disease, and wherein the apparatus is adapted to treat the Meniere's disease.
3. The apparatus according to claim 1, wherein the condition is selected from the list consisting of: acoustic neurinoma and acoustic neuroma, and wherein the apparatus is
20 adapted to treat the selected condition.
4. The apparatus according to claim 1, wherein the condition includes post-traumatic vertigo, and wherein the apparatus is adapted to treat the post-traumatic vertigo.
5. The apparatus according to claim 1, wherein the condition includes vestibular neuronitis, and wherein the apparatus is adapted to treat the vestibular neuronitis.
- 25 6. The apparatus according to claim 1, wherein the condition includes autoimmune inner ear disease (AIED), and wherein the apparatus is adapted to treat the AIED.
7. The apparatus according to claim 1, wherein the condition includes hearing loss, and wherein the apparatus is adapted to treat the hearing loss.
8. The apparatus according to claim 1, wherein the condition includes ototoxicity,
30 and wherein the apparatus is adapted to treat the ototoxicity.

9. The apparatus according to claim 1, wherein the condition includes a tumor of the ear, and wherein the apparatus is adapted to treat the tumor.
10. The apparatus according to claim 1, wherein the site includes the otic ganglion of the subject, and wherein the stimulator is adapted to stimulate the otic ganglion of the subject.
11. The apparatus according to claim 1, wherein the site includes the afferent fiber going into the otic ganglion of the subject, and wherein the stimulator is adapted to stimulate the afferent fiber.
12. The apparatus according to claim 1, wherein the site includes the efferent fiber going out of the otic ganglion of the subject, and wherein the stimulator is adapted to stimulate the efferent fiber.
13. The apparatus according to claim 1, wherein the site includes the SPG of the subject, and wherein the stimulator is adapted to stimulate the SPG.
14. The apparatus according to claim 1, wherein the site includes the anterior ethmoidal nerve of the subject, and wherein the stimulator is adapted to stimulate the anterior ethmoidal nerve.
15. The apparatus according to claim 1, wherein the site includes the posterior ethmoidal nerve of the subject, and wherein the stimulator is adapted to stimulate the posterior ethmoidal nerve.
16. The apparatus according to claim 1, wherein the site includes the communicating branch between the anterior ethmoidal nerve and the retro-orbital branch of the SPG of the subject, and wherein the stimulator is adapted to stimulate the communicating branch.
17. The apparatus according to claim 1, wherein the site includes the communicating branch between the posterior ethmoidal nerve and the retro-orbital branch of the SPG of the subject, and wherein the stimulator is adapted to stimulate the communicating branch.
18. The apparatus according to claim 1, wherein the site includes the greater palatine nerve of the subject, and wherein the stimulator is adapted to stimulate the greater palatine nerve.

19. The apparatus according to claim 1, wherein the site includes the lesser palatine nerve of the subject, and wherein the stimulator is adapted to stimulate the lesser palatine nerve.
20. The apparatus according to claim 1, wherein the site includes the sphenopalatine nerve of the subject, and wherein the stimulator is adapted to stimulate the sphenopalatine nerve.
21. The apparatus according to claim 1, wherein the site includes the communicating branch between the maxillary nerve and the SPG of the subject, and wherein the stimulator is adapted to stimulate the communicating branch.
22. The apparatus according to claim 1, wherein the site includes the nasopalatine nerve of the subject, and wherein the stimulator is adapted to stimulate the nasopalatine nerve.
23. The apparatus according to claim 1, wherein the site includes the posterior nasal nerve of the subject, and wherein the stimulator is adapted to stimulate the posterior nasal nerve.
24. The apparatus according to claim 1, wherein the site includes the infraorbital nerve of the subject, and wherein the stimulator is adapted to stimulate the infraorbital nerve.
25. The apparatus according to claim 1, wherein the site includes the vidian nerve of the subject, and wherein the stimulator is adapted to stimulate the vidian nerve.
26. The apparatus according to claim 1, wherein the site includes the greater superficial petrosal nerve of the subject, and wherein the stimulator is adapted to stimulate the greater superficial petrosal nerve.
27. The apparatus according to claim 1, wherein the site includes the lesser deep petrosal nerve of the subject, and wherein the stimulator is adapted to stimulate the lesser deep petrosal nerve.
28. The apparatus according to claim 1, wherein the stimulator is adapted to configure the stimulation of the site to induce an increase in cephalic blood flow of the subject sufficient to treat the ear condition.

29. The apparatus according to claim 1, wherein the stimulator is adapted to configure the stimulation of the site to induce an increase in otic blood flow of the subject sufficient to treat the ear condition.
30. The apparatus according to claim 1, wherein the stimulator is adapted to configure the stimulation of the site to induce an increase in vasomotor control over blood vessels associated with a vestibulocochlear nerve of the subject sufficient to increase clearance, from an inner ear of the ear, of at least one constituent accumulated in the inner ear, the at least one constituent selected from the list consisting of: a metabolite and fluid.
31. The apparatus according to any one of claims 1-30, wherein the condition includes dizziness, and wherein the apparatus is adapted to treat the dizziness.
32. The apparatus according to claim 31, wherein the stimulator is adapted to configure the stimulation of the site to increase blood flow to structures of an inner ear of the ear to a level sufficient to treat the dizziness.
33. The apparatus according to any one of claims 1-30, wherein the condition includes sudden sensorineural hearing loss (SSHL), and wherein the apparatus is adapted to treat the SSHL.
34. The apparatus according to claim 33, wherein the stimulator is adapted to configure the stimulation of the site to increase blood flow to structures of an inner ear of the ear to a level sufficient to treat the SSHL.
35. The apparatus according to any one of claims 1-30, wherein the condition includes inner-ear ischemia, and wherein the apparatus is adapted to treat the inner-ear ischemia.
36. The apparatus according to claim 35, wherein the stimulator is adapted to configure the stimulation of the site to induce an increase in blood flow in a region of an inner ear of the ear to a level sufficient to treat the inner-ear ischemia.
37. The apparatus according to any one of claims 1-30, wherein the stimulator is adapted to configure the stimulation of the site to induce an increase in molecular passage across a blood brain barrier (BBB) of the subject.
38. The apparatus according to claim 37, wherein the stimulator is adapted to configure the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of a therapeutic agent from a systemic blood circulation

of the subject through the BBB into a vicinity of the ear of the subject, so as to treat the ear condition.

39. The apparatus according to claim 38, wherein the therapeutic agent is selected from the list consisting of: a chemotherapeutic agent, a diuretic, an anti-inflammatory
5 drug, an anti-viral drug, an anti-bacterial drug, a transtympanic agent, and an anti-Tumor Necrosis Factor compound, and wherein the stimulator is adapted to configure the stimulation of the site to increase the molecular passage across the BBB to the magnitude that increases passage of the selected therapeutic agent.

40. The apparatus according to claim 38, wherein the stimulator is adapted to
10 configure the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of the therapeutic agent from the systemic blood circulation through the BBB into a vicinity of a vestibulocochlear nerve of the subject.

41. The apparatus according to claim 38, wherein the therapeutic agent includes a neurotrophic factor, and wherein the stimulator is adapted to configure the stimulation of
15 the site to increase the molecular passage across the BBB to a magnitude that increases passage of the neurotrophic factor.

42. The apparatus according to claim 41, wherein the neurotrophic factor is selected from the list consisting of: GDNF, BDNF, NT3, NT4/5, Ig NGF, IL-6, LIF, CNTF, OSM, CNTF, LIF, IGF-1, IGF-2, TGF-alpha, TGF-beta 1, TGF-beta 2, TGF-beta 3, NTN, PSP,
20 PDGF, SCF, CNTF, and IGF2, and wherein the stimulator is adapted to configure the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of the selected neurotrophic factor.

43. The apparatus according to any one of claims 1-30, wherein the stimulator comprises an electrical stimulator, adapted to drive a current into the site, so as to
25 stimulate the site.

44. The apparatus according to claim 43, wherein the electrical stimulator is adapted to be implanted in a body of the subject.

45. The apparatus according to claim 43, wherein the electrical stimulator comprises:
at least one electrode, adapted to be placed in a vicinity of the site; and
30 a control unit, adapted to drive the electrode to apply the current to the site.

46. The apparatus according to claim 45, wherein the electrode is adapted to be implanted in the vicinity of the site.
47. The apparatus according to claim 45, wherein the site includes a first site and a second site, at least 2 mm from the first site, and wherein the at least one electrode
5 comprises a first electrode and a second electrode, the first electrode adapted to be placed in a vicinity of the first site, and the second electrode adapted to be placed in a vicinity of the second site.
48. The apparatus according to any one of claims 1-30, wherein the stimulator comprises a chemical stimulator device, adapted to apply a neuroexcitatory agent to the
10 site at a dosage sufficient to stimulate the site.
49. The apparatus according to claim 48, wherein the neuroexcitatory agent includes acetylcholine, and wherein the chemical stimulator device is adapted to apply the acetylcholine.
50. The apparatus according to claim 48, wherein the neuroexcitatory agent includes
15 urecholine, and wherein the chemical stimulator device is adapted to apply the urecholine.
51. The apparatus according to any one of claims 1-30, wherein the stimulator comprises a mechanical stimulator device, adapted to apply mechanical stimulation to the site.
52. The apparatus according to claim 51, wherein the mechanical stimulator device is
20 adapted to apply vibration to the site.
53. A method for treating a condition of an ear of a subject, comprising stimulating at least one site of the subject, so as to treat the ear condition, the site selected from the list consisting of: an otic ganglion of the subject, an afferent fiber going into the otic ganglion of the subject, an efferent fiber going out of the otic ganglion of the subject, a
25 sphenopalatine ganglion (SPG) of the subject, an anterior ethmoidal nerve of the subject, a posterior ethmoidal nerve of the subject, a communicating branch between an anterior ethmoidal nerve and a retro-orbital branch of an SPG of the subject, a communicating branch between a posterior ethmoidal nerve and a retro-orbital branch of an SPG of the subject, a greater palatine nerve of the subject, a lesser palatine nerve of the subject, a
30 sphenopalatine nerve of the subject, a communicating branch between a maxillary nerve and an SPG of the subject, a nasopalatine nerve of the subject, a posterior nasal nerve of

the subject, an infraorbital nerve of the subject, a vidian nerve of the subject, a greater superficial petrosal nerve of the subject, and a lesser deep petrosal nerve of the subject.

54. The method according to claim 53, wherein the condition includes Meniere's disease, and wherein stimulating the site comprises stimulating the site so as to treat the
5 Meniere's disease.

55. The method according to claim 53, wherein the condition is selected from the list consisting of: acoustic neurinoma and acoustic neuroma, and wherein stimulating the site comprises stimulating the site so as to treat the selected condition.

56. The method according to claim 53, wherein the condition includes post-traumatic
10 vertigo, and wherein stimulating the site comprises stimulating the site so as to treat the post-traumatic vertigo.

57. The method according to claim 53, wherein the condition includes vestibular neuronitis, and wherein stimulating the site comprises stimulating the site so as to treat the vestibular neuronitis.

15 58. The method according to claim 53, wherein the condition includes autoimmune inner ear disease (AIED), and wherein stimulating the site comprises stimulating the site so as to treat the AIED.

59. The method according to claim 53, wherein the condition includes hearing loss, and wherein stimulating the site comprises stimulating the site so as to treat the hearing
20 loss.

60. The method according to claim 53, wherein the condition includes ototoxicity, and wherein stimulating the site comprises stimulating the site so as to treat the ototoxicity.

61. The method according to claim 53, wherein the condition includes a tumor of the ear, and wherein stimulating the site comprises stimulating the site so as to treat the
25 tumor.

62. The method according to claim 53, wherein the site includes the otic ganglion of the subject, and wherein stimulating the site comprises stimulating the otic ganglion of the subject, so as to treat the ear condition.

63. The method according to claim 53, wherein the site includes the afferent fiber going into the otic ganglion of the subject, and wherein stimulating the site comprises stimulating the afferent fiber, so as to treat the ear condition.
- 5 64. The method according to claim 53, wherein the site includes the efferent fiber going out of the otic ganglion of the subject, and wherein stimulating the site comprises stimulating the efferent fiber, so as to treat the ear condition.
65. The method according to claim 53, wherein the site includes the SPG of the subject, and wherein stimulating the site comprises stimulating the SPG, so as to treat the ear condition.
- 10 66. The method according to claim 53, wherein the site includes the anterior ethmoidal nerve of the subject, and wherein stimulating the site comprises stimulating the anterior ethmoidal nerve, so as to treat the ear condition.
67. The method according to claim 53, wherein the site includes the posterior ethmoidal nerve of the subject, and wherein stimulating the site comprises stimulating the posterior ethmoidal nerve, so as to treat the ear condition.
- 15 68. The method according to claim 53, wherein the site includes the communicating branch between the anterior ethmoidal nerve and the retro-orbital branch of the SPG of the subject, and wherein stimulating the site comprises stimulating the communicating branch, so as to treat the ear condition.
- 20 69. The method according to claim 53, wherein the site includes the communicating branch between the posterior ethmoidal nerve and the retro-orbital branch of the SPG of the subject, and wherein stimulating the site comprises stimulating the communicating branch, so as to treat the ear condition.
- 25 70. The method according to claim 53, wherein the site includes the greater palatine nerve of the subject, and wherein stimulating the site comprises stimulating the greater palatine nerve, so as to treat the ear condition.
71. The method according to claim 53, wherein the site includes the lesser palatine nerve of the subject, and wherein stimulating the site comprises stimulating the lesser palatine nerve, so as to treat the ear condition.

72. The method according to claim 53, wherein the site includes the sphenopalatine nerve of the subject, and wherein stimulating the site comprises stimulating the sphenopalatine nerve, so as to treat the ear condition.
73. The method according to claim 53, wherein the site includes the communicating
5 branch between the maxillary nerve and the SPG of the subject, and wherein stimulating the site comprises stimulating the communicating branch, so as to treat the ear condition.
74. The method according to claim 53, wherein the site includes the nasopalatine nerve of the subject, and wherein stimulating the site comprises stimulating the nasopalatine nerve, so as to treat the ear condition.
- 10 75. The method according to claim 53, wherein the site includes the posterior nasal nerve of the subject, and wherein stimulating the site comprises stimulating the posterior nasal nerve, so as to treat the ear condition.
76. The method according to claim 53, wherein the site includes the infraorbital nerve of the subject, and wherein stimulating the site comprises stimulating the infraorbital
15 nerve, so as to treat the ear condition.
77. The method according to claim 53, wherein the site includes the vidian nerve of the subject, and wherein stimulating the site comprises stimulating the vidian nerve, so as to treat the ear condition.
78. The method according to claim 53, wherein the site includes the greater superficial
20 petrosal nerve of the subject, and wherein stimulating the site comprises stimulating the greater superficial petrosal nerve, so as to treat the ear condition.
79. The method according to claim 53, wherein the site includes the lesser deep petrosal nerve of the subject, and wherein stimulating the site comprises stimulating the lesser deep petrosal nerve, so as to treat the ear condition.
- 25 80. The method according to claim 53, wherein stimulating the site comprises configuring the stimulation of the site to induce an increase in cephalic blood flow of the subject sufficient to treat the ear condition.
81. The method according to claim 53, wherein stimulating the site comprises configuring the stimulation of the site to induce an increase in otic blood flow of the
30 subject sufficient to treat the ear condition.

82. The method according to claim 53, wherein stimulating the site comprises configuring the stimulation of the site to induce an increase in vasomotor control over blood vessels associated with a vestibulocochlear nerve of the subject sufficient to increase clearance, from an inner ear of the ear, of at least one constituent accumulated in the inner ear, the at least one constituent selected from the list consisting of: a metabolite and fluid, so as to treat the ear condition.

83. The method according to any one of claims 53-82, wherein the condition includes dizziness, and wherein stimulating the site comprises stimulating the site so as to treat the dizziness.

84. The method according to claim 83, wherein stimulating the site comprises configuring the stimulation of the site to increase blood flow to structures of an inner ear of the ear to a level sufficient to treat the dizziness.

85. The method according to any one of claims 53-82, wherein the condition includes sudden sensorineural hearing loss (SSHL), and wherein stimulating the site comprises stimulating the site so as to treat the SSLH.

86. The method according to claim 85, wherein stimulating the site comprises configuring the stimulation of the site to increase blood flow to structures of an inner ear of the ear to a level sufficient to treat the SSLH.

87. The method according to any one of claims 53-82, wherein the condition includes inner-ear ischemia, and wherein stimulating the site comprises stimulating the site so as to treat the inner-ear ischemia.

88. The method according to claim 87, wherein stimulating the site comprises configuring the stimulation of the site to induce an increase in blood flow in a region of an inner ear of the ear to a level sufficient to treat the inner-ear ischemia.

89. The method according to any one of claims 53-82, wherein stimulating the site comprises configuring the stimulation of the site to induce an increase in molecular passage across a blood brain barrier (BBB) of the subject.

90. The method according to claim 89, wherein stimulating the site comprises configuring the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of a therapeutic agent from a systemic blood

circulation of the subject through the BBB into a vicinity of the ear of the subject, so as to treat the ear condition.

91. The method according to claim 90, wherein the therapeutic agent is selected from the list consisting of: a chemotherapeutic agent, a diuretic, an anti-inflammatory drug, an anti-viral drug, an anti-bacterial drug, a transtympanic agent, and an anti-Tumor Necrosis Factor compound, and wherein stimulating the site comprises configuring the stimulation of the site to increase the molecular passage across the BBB to the magnitude that increases passage of the selected therapeutic agent.
92. The method according to claim 90, wherein stimulating the site comprises configuring the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of the therapeutic agent from the systemic blood circulation through the BBB into a vicinity of a vestibulocochlear nerve of the subject.
93. The method according to claim 90, wherein the therapeutic agent includes a neurotrophic factor, and wherein stimulating the site comprises configuring the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of the neurotrophic factor.
94. The method according to claim 93, wherein the neurotrophic factor is selected from the list consisting of: GDNF, BDNF, NT3, NT4/5, Ig NGF, IL-6, LIF, CNTF, OSM, CNTF, LIF, IGF-1, IGF-2, TGF-alpha, TGF-beta 1, TGF-beta 2, TGF-beta 3, NTN, PSP, PDGF, SCF, CNTF, and IGF2, and wherein stimulating the site comprises configuring the stimulation of the site to increase the molecular passage across the BBB to a magnitude that increases passage of the selected neurotrophic factor.
95. The method according to any one of claims 53-82, wherein stimulating the site comprises driving an electrical current into the site, so as to stimulate the site.
96. The method according to claim 95, wherein driving the current into the site comprises implanting an electrical stimulator in a body of the subject.
97. The method according to claim 95, wherein the site includes a first site and a second site, at least 2 mm from the first site, and wherein the at least one electrode comprises a first electrode and a second electrode, and wherein driving the current comprises driving the current between the first site and the second site.

98. The method according to any one of claims 53-82, wherein stimulating the site comprises applying a neuroexcitatory agent to the site at a dosage sufficient to stimulate the site.
99. The method according to claim 98, wherein the neuroexcitatory agent includes acetylcholine, and wherein applying the neuroexcitatory agent comprises applying the acetylcholine.
100. The method according to claim 98, wherein the neuroexcitatory agent includes an acetylcholine-like molecule, and wherein applying the neuroexcitatory agent comprises applying the acetylcholine-like molecule.
101. The method according to claim 98, wherein the neuroexcitatory agent includes urecholine, and wherein applying the neuroexcitatory agent comprises applying the urecholine.
102. The method according to any one of claims 53-82, wherein stimulating the site comprises applying mechanical stimulation to the site.
103. The method according to claim 102, wherein applying the mechanical stimulation to the site comprises applying vibration to the site.
104. The apparatus according to claim 48, wherein the neuroexcitatory agent includes an acetylcholine-like molecule, and wherein the chemical stimulator device is adapted to apply the acetylcholine-like molecule.